correspondence between isotopic numbers which differ by 4, or by the formula p_4e_4, which may be assumed to represent an α-particle *plus* two cementing or β-electrons. The relations of the light atoms are thus very similar to those of the radio-active atoms.

It may be of interest to note that during an α-change there is no change in the isotopic number; in a β-disintegration the isotopic number decreases by 2. Of these two units one is due to the decrease of the number of negative electrons in the nucleus by one, and the other to the resultant increase of the atomic number (M) by one. The addition of a proton to a nucleus would increase the atomic number and decrease the isotopic number by one each. Thus the addition of a positive electron to the nucleus of Mg 12_2^{26} would give 13_1^{27}, which is ordinary aluminium.

The negative electrons in atom nuclei seem to be usually associated in pairs. Thus in the β-disintegrations of the radio-active elements two electrons escape in succession. This pairing may explain the fact that while most atoms have the formula $(p_2e)_M$, with M an even number, extremely few have the same formula when M is odd. Thus if p_2e should prove to be the primary group in atom-building, nevertheless the most abundant group in existing nuclei would be expected to have the formula (p_2e) or that of an α-particle. WILLIAM D. HARKINS.

University of Chicago, February 4.

Light and Electrons.

WITH reference to Sir Oliver Lodge's letter in NATURE of April 7, some few weeks ago I fitted a flat speculum mirror to a centrifuge capable of being run at 150 revolutions per second. The other arrangements—not yet completed—are as follows:—The image of a brightly illuminated slit is focussed on the mirror; a second slit is placed at a distance of about 10 metres.

(1) The eye is placed behind the second slit and the centrifuge increased in speed until the flash is no longer seen. If the slits are 1 mm. wide a duration of flash of 10^{-7} sec. is attainable. If necessary, the radius of the rotating beam may be increased.

(2) The eye is replaced by a photographic plate. This is a test for electrons released from the sensitiser. Below a certain duration of flash there should be no latent image formed, however often the flash is repeated.

(3) A light-sensitive photo-electric cell is also tested. In this manner Mr. J. H. Poole and I have planned to test the very point raised by Sir Oliver Lodge, and also to seek for evidence respecting the quantum theory of vision.

At present there is only this much to go on. It is stated (Halliburton's "Physiology") that a flash of $1{\cdot}25 \times 10^{-7}$ sec. duration is still visible. This (if it is the limit) affords a length of 4×10^3 cm. for the length of the train of waves activating an electron in the retina. If it is allowable to go further we find the energy of a single wave (of green light) to be about 6×10^{-20} erg. J. JOLY.

Trinity College, Dublin, April 8.

Molecular Structure and Energy.

THE question which Prof. Partington raises in his letter under the above title in NATURE of April 7, p. 172, is an important one which I would prefer should be answered by others more qualified to do so than myself. I intervene principally to correct the impression given in the letter that the structures of the various molecules with which I have dealt in recent communications have been proposed by me. This is not so. All that I have done is to show that the structures of certain polyatomic molecules, including some halogen gases, carbon dioxide, and nitrous oxide, postulated by Lewis and Langmuir are consistent with viscosity data and X-ray crystal data taken together. The procedure deals with the *external* shapes of the molecules only, and not with the internal energy of their nuclei; and it appears to be justified by the calculations of Prof. S. Chapman (Phil. Trans., vol. ccxvi., p. 347), who says: ". . . the internal energy which prevents the application of our formulæ to the conductivity of polyatomic gases hardly affects viscosity."

Prof. Partington's views appear to be open to criticism even if we leave out of account entirely the necessity for revising earlier ideas of energy partition on the basis of the quantum theory. For example, Langmuir's proposed structure for the nitrogen molecule is not spherically symmetrical in the same sense as are the atoms of the inert gases. There are *two separate* massive nuclei instead of one, and this involves the possibility of rotational internal energy of the same type as in the oxygen molecule, so that the ratio of the principal specific heats could not be expected to be so high as 1·667. Also, is it not possible, indeed probable, that the nuclei of all polyatomic molecules are capable of vibration to and fro? Such motions are, I believe, known to exist in the gaseous hydrogen halides, as well as the rotations to which attention has recently been directed by Prof. W. L. Bragg and Mr. H. Bell (NATURE, March 24, p. 107).

A. O. RANKINE.

Imperial College of Science and Technology,
April 7.

The Normal Orbit of the Electron in the Atom of Mercury.

RESEARCHES on ionisation and resonance potentials of mercury vapour and on its ultra-violet absorption in a non-luminous state, together with considerations from the serial type of the mercury spectrum, lead to the definite conclusion that in the absence of exciting agencies the spectral electron remains on the orbit 1S, the normal orbit of the atom of mercury. On the other hand, R. Dearle has shown the presence of a strong infra-red absorption band at $\lambda = 10140$, and this fact has suggested the possibility of a second normal orbit in the mercury atom, namely, the orbit 2P. The corresponding ionisation and resonance potentials have, however, never been observed. This problem induced us to make an absorption experiment with non-luminous mercury vapour in the infra-red region, using a photographic method which enabled us easily to reach $\lambda = 11300$ Å. All the photographs showed complete absence of a marked absorption at $\lambda = 10140$, although the pressure of mercury vapour reached 1 atm. The efficiency of the method having been established, the absence of a strong and characteristic absorption of $\lambda = 10140$ by mercury vapour has been shown and the necessity for a second normal orbit is avoided. A. TERENIN.

Optical Institute, Petrograd, December, 1920.

Doublets in Spectral Series.

THE physicists of Petrograd have recently become acquainted with a paper by Wood and Mohler (*Phil. Mag.*, April, 1919) on resonance in sodium vapour.

© 1921 Nature Publishing Group

When the excitation is produced by D_1, the ratio of intensities of the two resonating lines D_2 and D_1, which is very small when the temperature and density are low, rapidly increases to its normal value 2 with the number of atomic collisions per second. This number is thus given statistical significance. Until now there has been no strong evidence (Wood, 1914) as to its invariability at higher temperatures and pressures.

Special investigations on this subject made in 1915 and 1917, and published in Russia, appear to be unknown abroad. The dispersion of the vapour of alkali metals was studied in 1915. For all the first doublets of Na, K, Rb, and Cs the same value 2 was obtained, and it remained constant in spite of a hundredfold density variation; for the second doublets the numbers are simple, but different: 2 (?), 2, 2·5, 4. The numbers 3 and 7 (?) were measured for the third doublets of Rb and Cs. Mr. Touroverow (1917) found the same number 2 for the first sodium doublet at the temperature of the arc. There is, therefore, no doubt now as to the constancy of all the above numbers. The experiments on resonance thus show that the statistical value in question first grows rapidly with the temperature and approaches a limiting value, essentially constant. This behaviour has a certain analogy to that of specific heat as caused by departure from equipartition.

D. ROGESTVENSKY.

Petrograd University Physical Institute,
March.

The Resonance Theory of Hearing.

THE discussions which appeared in NATURE in 1918 (vol. cii., pp. 124, 164, 184) on the theory of hearing showed that the opinion has been gaining ground lately that the resonance theory can no longer be regarded as unassailable. The following observation, which is readily explicable if there are resonators in the internal ear, would appear to be inexplicable if there are not:

If the phase of a continuous musical note be suddenly altered by suitable means by π, then the observer hears the sound rapidly die away, to return a moment later with its former intensity. The experiment was performed as follows:

A De la Tour siren was so modified that the wind-chest could be given suddenly a small rotation about the same axis as that of the siren disc. The rotation was limited by fixed stops, so that the angle turned through was equal to one-half the angle between two of the air-holes. In the writer's instrument there were eighteen holes arranged on the circumference, *i.e.* 20° between two of the holes, and the wind-chest was therefore arranged to rotate through 10°. If, then, this rotation is suddenly effected with the siren in action, a change in the phase of the note of π will be introduced; since, if the rotation of the wind-chest be in the same direction as that of the disc, the time-interval between the puffs of wind through the disc will be $1\frac{1}{2}$ times as great as the normal, because the disc has to rotate through $20° + 10°$; if, on the other hand, the rotation of the wind-chest be in the opposite direction to that of the disc, the time-interval will be one-half the normal, since the disc has to rotate through $20° - 10°$. Each time, then, that this change of phase of π is brought about by rotation of the wind-chest of the siren the observer hears a beat in the musical note. The sound intensity first falls to a low value, then rapidly rises somewhat above the original level (possibly due to successive contrast), and then returns and stays at the normal intensity. To show that the beat is not of mechanical production the following tests may be applied:

(*a*) No beat is produced if the wind-chest is rotated slowly.

(*b*) No beat is produced if, with the disc in rotation, the air-supply be quickly turned off and the wind-chest then rotated suddenly in either direction.

(*c*) The beat can be heard as clearly at a considerable distance from the instrument as it can quite near to it.

(*d*) If the rotation of the wind-chest is less than that required to change the phase by π, the beat or temporary waning of the note is correspondingly smaller in intensity.

This temporary waning of the note is readily explained by the resonance theory, because the change in phase will put the later vibrations exactly out of step with those that preceded, and therefore the resonators of the internal ear which are set in vibration by the note will on change of phase first be brought to rest and then be set going again. The temporary waning of the note is therefore readily explained on the resonance theory. Can any of your readers advance an explanation on any of the displacement (*e.g.* Wrightson's) hypotheses of hearing?

H. HARTRIDGE.

King's College, Cambridge, March 21.

Sexual Organs of Phytophthora.

ATTENTION was directed in NATURE of April 30, 1914 (vol. xciii., p. 226), to the discovery of a rather remarkable mode of development of sexual organs which occurs in certain species of Phytophthora, and was first found in *P. erythroseptica* and then in *P. infestans*, the "potato-blight" fungus. Several other species of the genus are now known to produce sexual organs in this novel fashion, in which the oogonial incept penetrates the antheridium at an early stage, traverses it, emerges, and then swells to form the oogonium proper within which the oospore ultimately develops. It was suggested then that those previously well-known species (such as *P. cactorum*, etc.) in which the antheridium and the oogonium lie side by side, and penetration of the latter by the former occurs laterally, should be excluded from the genus Phytophthora and be placed in a new one, Nozemia. A species (from decaying apples) has now been isolated by Mr. H. A. Lafferty, working here, in which the sexual organs are developed mainly according to the Nozemia type, but occasionally and simultaneously in the same individual according to the Phytophthora type, with amphigynal antheridia. This species, therefore, forms a connecting link between the two groups; and it would seem no longer necessary or desirable to retain the generic name Nozemia.

The object of this letter is to suggest to the various mycologists who are now working with Phytophthoras that they should keep a very careful look-out in cultures of species of the *Cactorum* or *omnivora* (Nozemia) type for the occasional occurrence of sexual organs with amphigynal antheridia; for it seems quite possible that these may be present in such species and have merely been overlooked by previous observers owing to their relatively infrequent occurrence.

I should be very grateful for sub-cultures of any species of Phytophthora that mycologists who have them could spare for further study of this point, and happy to send any I possess in exchange if desired.

GEO. H. PETHYBRIDGE.

Royal College of Science, Dublin, April 7.

© 1921 Nature Publishing Group